

ENHANCING SHADED RELIEF WITH TERRAIN TEXTURE SHADER

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Introduction

Terrain Texture Shader is a Mac application developed by Natural Graphics that reads Digital Elevation Models (DEMs) and renders them as images with increased contrast and detail, especially in the areas of a terrain where elevation changes abruptly (Figure 1). The basis for the software is an algorithm developed by Leland Brown and presented at the 2010 NACIS conference. A command-line application (for Mac and Windows) written by Brown was the only way to create a texture shade rendering prior to the release of Terrain Texture Shader (see references).

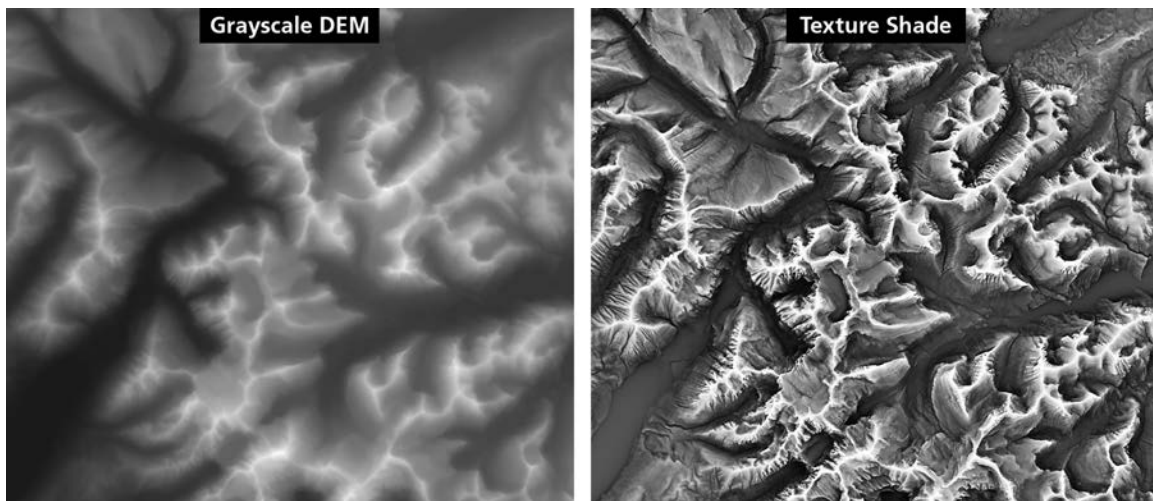


Figure 1. A grayscale DEM rendered as a texture shade using the default settings in Terrain Texture Shader. Area shown: Glacier National Park, Montana.

Brown originally envisioned his technique as a presentation alternative to conventional shaded relief, which he found lacking for mapping the rugged mountains of southern California where he often goes hiking (see references). In Brown's opinion, a shaded relief illuminated starkly with a single light source is less successful at depicting subtle terrain differences than a texture shade. The problem with a texture shade by itself is that it looks nothing like the terrain we are accustomed to seeing on maps. It can be mistaken for a medical X-ray. In addition, the contrasting dark valleys and light ridges can interfere with other map information, such as labels.

The issues just described prevent the use of texture shading for stand-alone relief presentation. A more practical use, however, is for mapmakers to merge it with shaded relief to create a hybrid product (Figure 2).

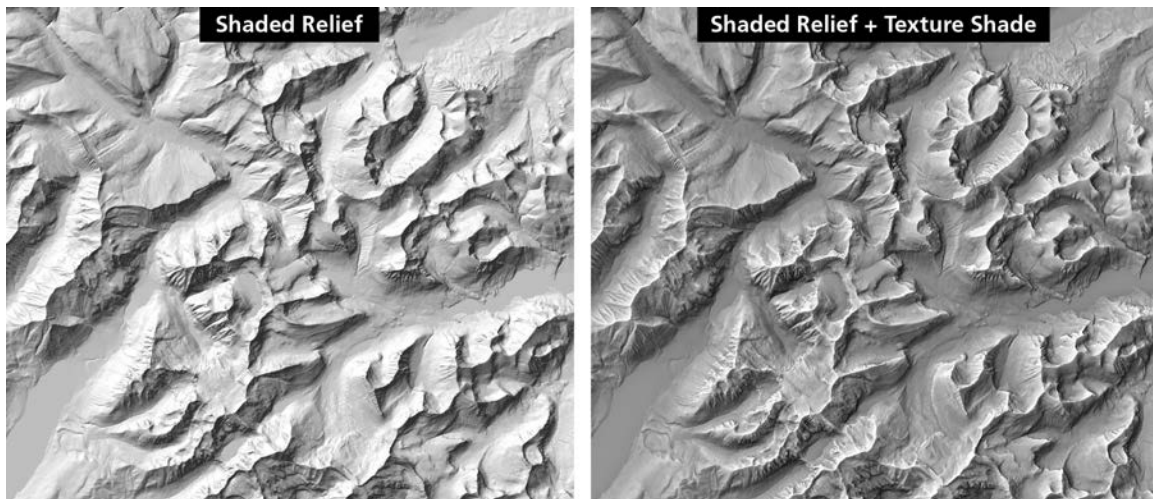


Figure 2. Shaded relief compared to merged shaded relief + texture shade near Logan Pass, Glacier National Park, Montana.

Combining texture shading with a shaded relief can bring a number of advantages to a cartographic relief presentation: On maps with a mix of lowland and mountain relief, details in the lowlands, such as lava flows, receive emphasis in a manner that does not detract from overall relief presentation (Figure 3). In mountain relief, steep illuminated slopes that have a tendency to become blown out have better definition, and shadowed slopes are not as dense. There is also more value in the mid-tones, which gives a shaded relief enhanced with texture shading more “body” and a less contrasting appearance. The general effect can resemble the manual relief art by Richard Edes Harrison and other cartographers from the mid-twentieth century (see references).

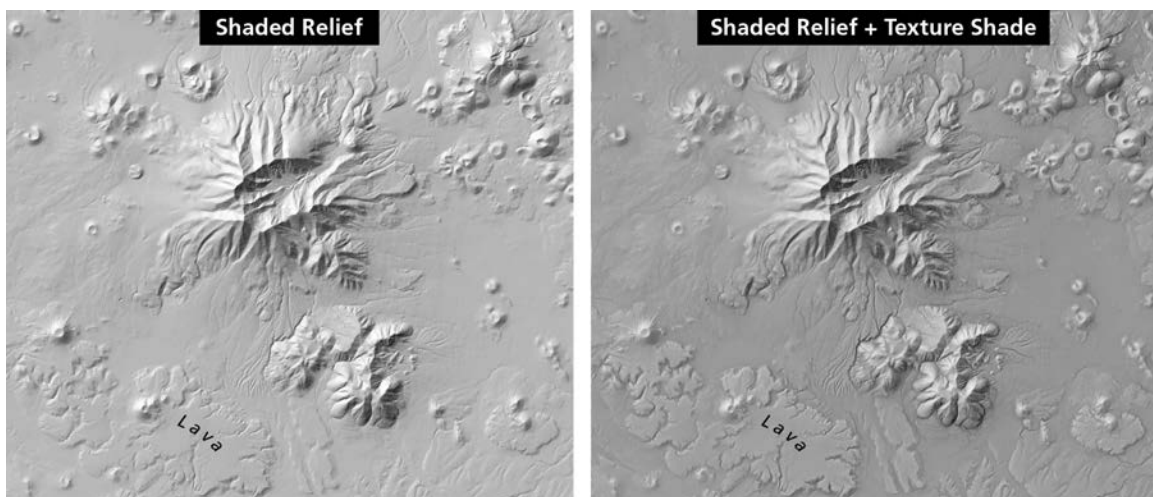


Figure 3. San Francisco Peaks, Arizona. Relatively low features, such as the lava flow, cinder cones, and drainages, appear more distinct on the enhanced relief (right).

The advantages of texture-shading enhancement go beyond a stylistic preference for relief presentation. On seemingly chaotic landscapes, it can reveal hidden patterns and barely perceptible terrain features, such as fault lines (Figure 4). This makes the technique potentially

useful as a visualization tool for geomorphologic analysis. It is applicable to DEMs at various map scales from continental regions to the smallest places detected by Lidar surveys.

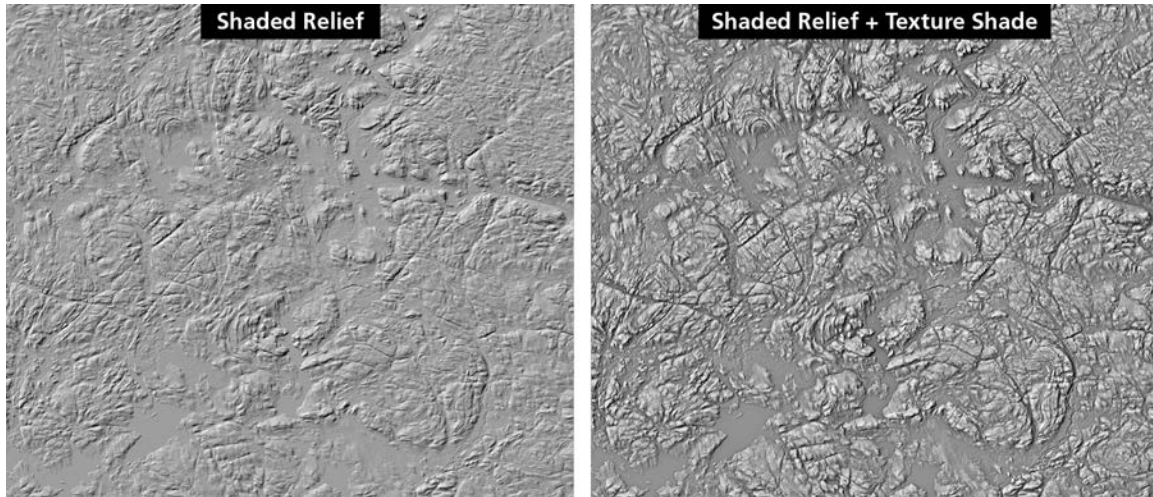


Figure 4. Canadian Shield, Quebec. The merged shaded relief + texture shade accentuates fault lines in low, broken terrain.

In early 2014, Brett Casebolt of Natural Graphics teamed up with Leland Brown to write Terrain Texture Shader. With a graphical user interface based on Natural Scene Designer (see references), terrain presentation software familiar to many cartographers, the new freeware application can generate texture shades quickly and easily.

Using Terrain Texture Shader

Terrain Texture Shader imports a variety of elevation data formats, including Natural Scene Designer files. Once elevation data are loaded in Terrain Texture Shader, tools are available in the *Terrain* drop menu to smooth, clip, and reproject the terrain. The *Render* drop menu accesses the dialog for rendering a texture shade (Figure 5).

The *Elevation/Texture* and *Vertical Enhancement* sliders are the main controls. Moving the *Elevation/Texture* slider to the right increases the amount of texture shading, and moving it to the left increases the amount of elevation data that appear in the rendered image. Moving the *Vertical Enhancement* slider from left to right increases the apparent contrast in the image.

Set the width and height to match the size of shaded relief image you will be combining with the texture shade. Doing this allows you to copy and paste images from one file to another in Photoshop. Terrain Texture Shader saves rendered images as GeoTIFFs, a useful format for working with GIS software.

The default Terrain Texture Shader render settings are a good place to start for your first texture shade. I also recommend rendering several others at different settings to give you design options later when compositing the texture shade with a shaded relief in Photoshop.

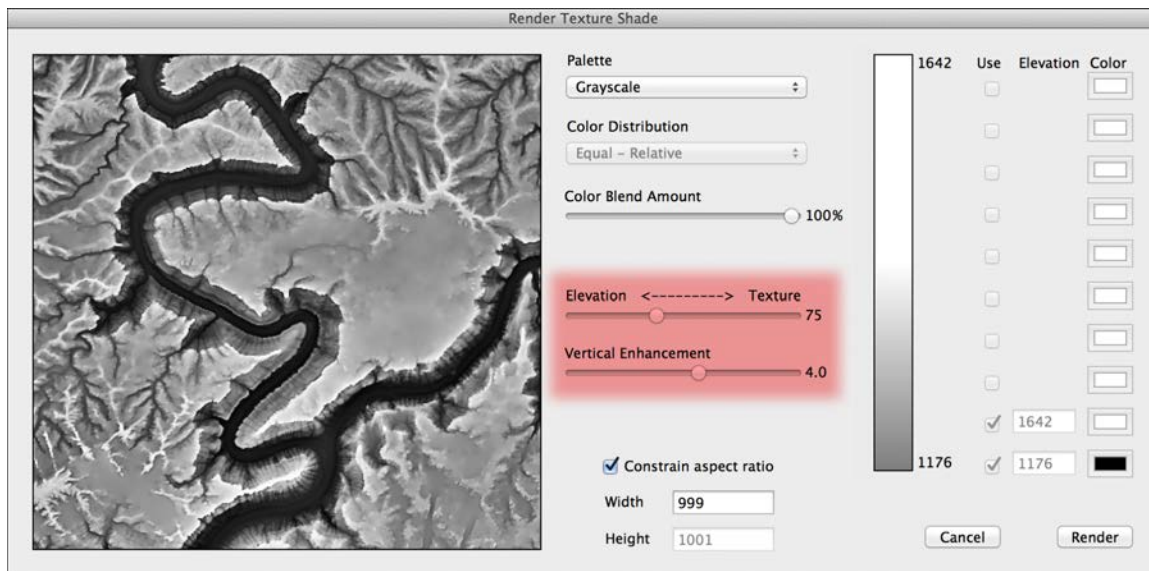


Figure 5. The Terrain Texture Shader render dialog with default settings. The sliders highlighted in red are the key controls.

Photoshop compositing

The real magic of texture shading happens in Photoshop. To merge a texture shade with a shaded relief, follow these steps:

- 1) In Photoshop, open your texture shading and the shaded relief you will combine with it as separate files. Copy and paste the shaded relief on a layer above the texture shading.
- 2) With the blending mode of the shaded relief layer set to the default *Normal*, reduce the layer opacity. This will allow the texture shading below to show through. In general, setting the shaded relief layer opacity between 50 and 80 percent works well for most terrains.
- 3) When the shaded relief layer opacity is closer to 50 percent, it may be necessary to add supplemental relief shadows. Follow this procedure:
 - A. Duplicate the shaded relief layer and set the opacity of the duplicated layer to 100 percent.
 - B. Use a curves adjustment to remove all value from flat areas, such as water bodies. Do this by sliding the highlight end of the curves adjustment horizontally until flat areas appear completely white.
 - C. Set the layer blending mode to *Multiply* and reduce the opacity considerably until the relief shadows look pleasing.
- 4) Other options include applying a *Curves* adjustment layer to the texture shading layer or an overall *Levels* adjustment to lighten or darken the entire image. Every terrain is different and a certain amount of experimentation is required to get the best results. Examine the linked file

below to get an idea of how this is done.

5) Finally, the procedure above will create a gray composite relief in RGB color mode, which can look sterile or metallic. Use a *Hue/Saturation* adjustment layer to tint the relief a more attractive color.

Rock textures

Terrain Texture Shader also offers a method to create automated textures from DEMs that somewhat resemble the hand-drawn rock hachures found on Swiss topographic maps (see references). The technique is most effective on cliffy landscapes with horizontal rock layers (Figure 6).

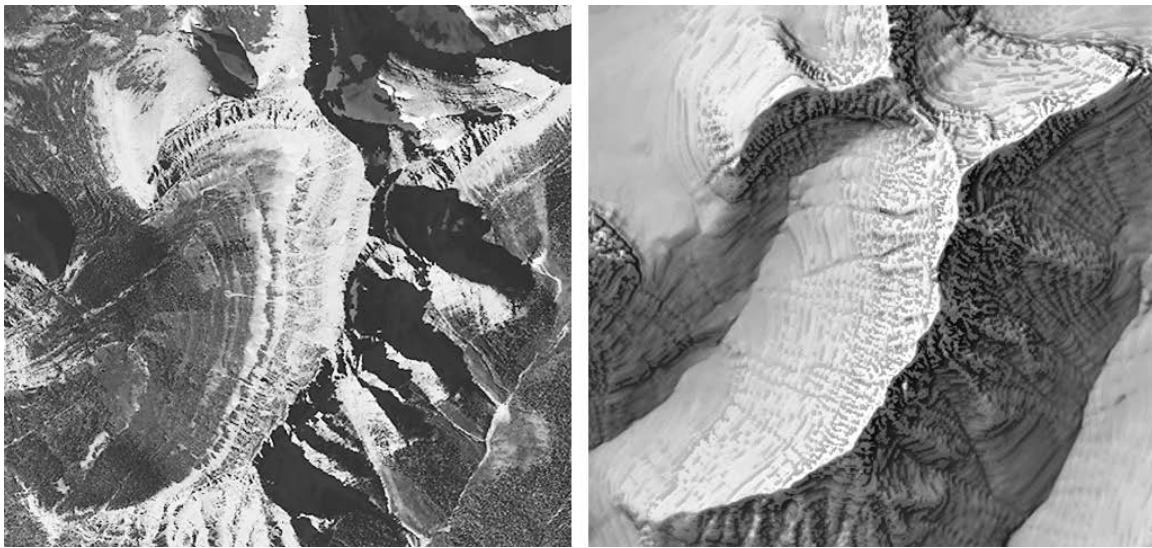


Figure 6. An aerial photograph (left) compared to rock textures generated by Terrain Texture Shader (right) of an unnamed mountain in Glacier National Park, Montana.

The procedure for creating rock textures is similar to that described above for combining a texture shade and shaded relief. The first step is rendering rock textures with Terrain Texture Shade. But instead of using the default render settings, move the *Elevation/Texture* slider all the way to the right to 200 and the *Vertical Enhancement* slider to the left to 0. This will result in a high-contrast and very detailed texture shade rendering that will represent the rock textures on your map. Next in Photoshop, copy and paste the rock texture rendering to a layer above the shaded relief layer, set the blending mode to either *Soft light* or *Hard light*, and adjust the layer opacity to vary the strength of the rock textures. Finally, by using a slope rendering (created in another program, such as Natural Scene Designer Pro) as a layer mask you can limit rock textures to only the steepest slopes (Figure 7).

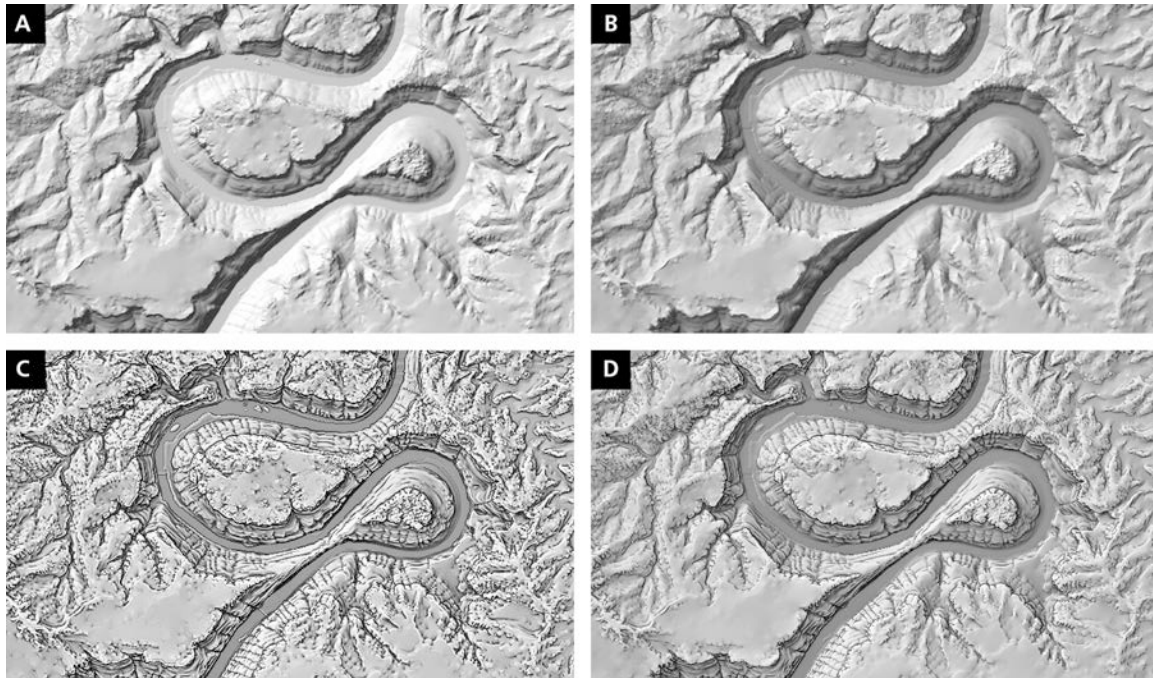


Figure 7. Creating rock textures, Canyonlands National Park, Utah. A) Shaded relief. B) Shaded relief merged with default texture shade. C) Rock texture shade applied everywhere. D) Rock texture shade applied only to steep slopes.

As a demonstration of the rock texturing technique, I created prototype maps of two very different landscapes. *The Heart of Canyonlands National Park* focuses on the confluence of the Colorado and Green rivers in Utah's canyon country, and *The Going-to-the-Sun Road* highlights a scenic highway crossing the spine of the Rockies in Glacier National Park, Montana. These maps are available as free downloads (see references).

Bradford Washburn's 1978 *The Heart of the Grand Canyon*, co-produced with National Geographic and with contributions from SwissTopo, inspired the design of *The Heart of Canyonlands National Park* map, and my choice of the map title. The arid-land textures on my map derive from shaded relief, texture shading, and NAIP aerial photos blended together. The river rapids are the only manual element, which I painted in Adobe Photoshop using NAIP as a guide (Figure 8). As an indication of how far cartographic production has advanced in the last 40 years, Washburn's map took seven years to complete, including field surveying, while my map took 32 hours to complete on a laptop in my living room.

In designing *The Going-to-the-Sun Road* map I drew inspiration from Swiss topographic maps characterized by green hypsometric tints in lowlands, mid-elevation slopes illuminated in warm yellow transitioning to white at the summits, and shadowed slopes depicted in cold gray-blue (Figure 9).

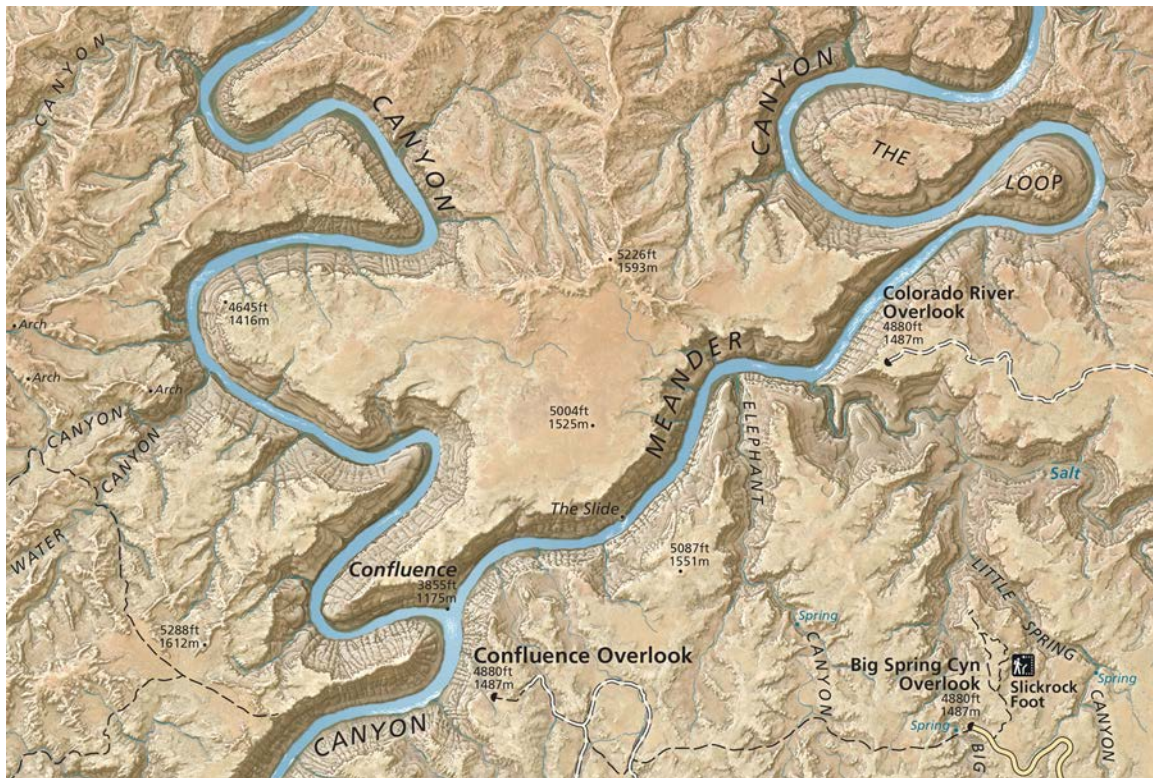


Figure 8. Excerpt of “The Heart of Canyonlands National Park” map.

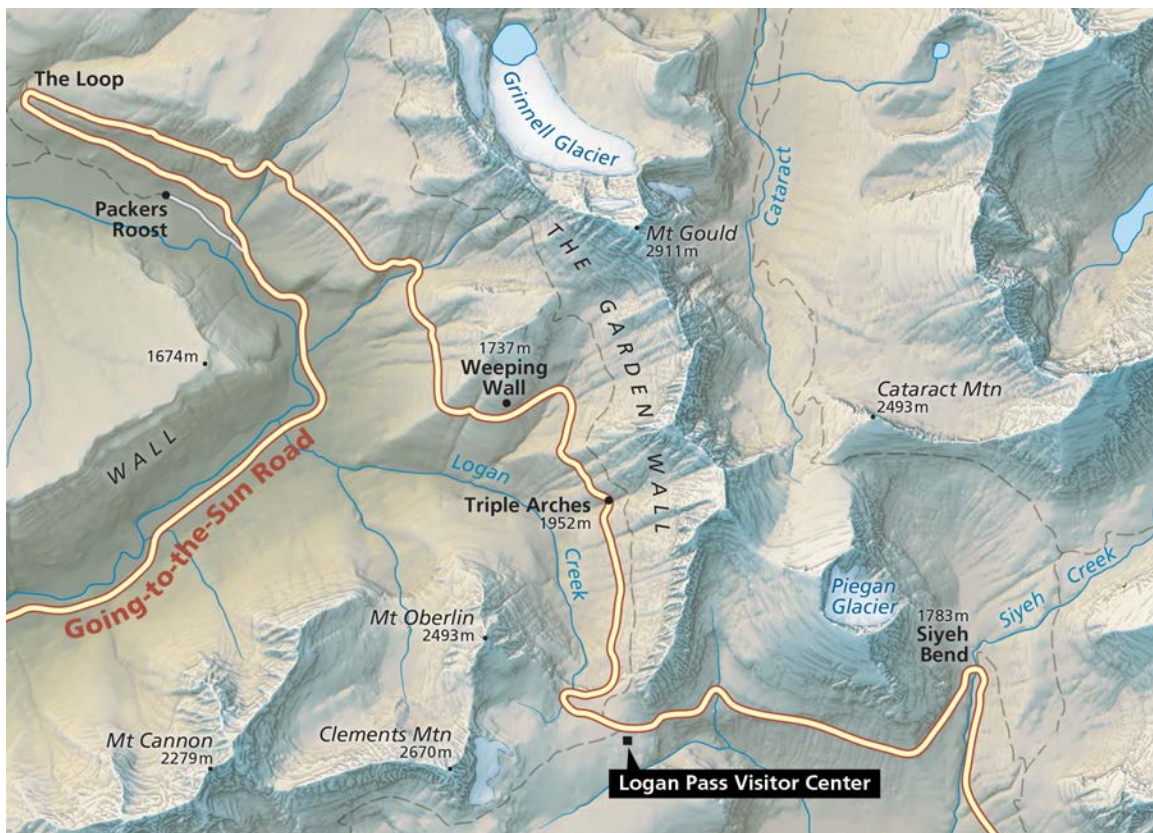


Figure 9. Excerpt of “The Going-to-the-Sun Road” map.

Not all places and elevation data are suited for rock texturing with Terrain Texture Shader. For example, the technique can produce terrace-like artifacts with DEMs created from contour lines, creating the false impression of horizontal rock layers in places where they do not exist (Figure 10, left). With DEMs created from Lidar data, excessive visual noise is a problem as well as unrealistic rock textures, such as the Crater Lake rim that look like candle wax drippings (Figure 10, right). Testing is the only way to find out if your DEM is suited to the technique, which takes only a few minutes to do.

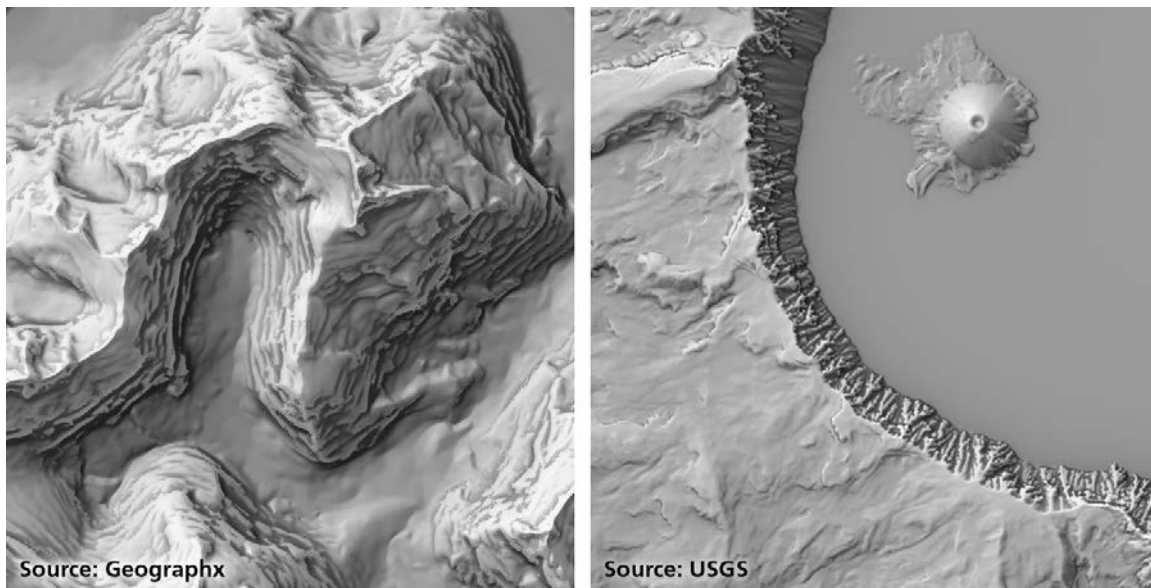


Figure 10. Poor examples of rock textures created with Terrain Texture Shader. (Left) Glaciated mountains in Fjordland National Park, New Zealand. (Right) The southwest rim of Crater Lake, Oregon.

Conclusion

The Terrain Texture Shader application can enhance shaded relief in two ways. A texture shade rendered from a DEM at the default settings and when merged with a shaded relief in Photoshop yields a product that appears more three-dimensional and reveals subtle terrain details not easily seen in stand-alone shaded relief. Almost every shaded relief can benefit from this treatment. Rock textures are the second enhancement option, but they are effective only for select places, such as landscapes with exposed, horizontal rock strata.

Three-dimensional mapping is another potential use for the Terrain Texture Shader application. For example, draping both default texture shades and rock textures on 3D landscapes can produce terrain art with a vaguely hand-drawn appearance (Figure 11). At the time of writing, Terrain Texture Shader has existed for only six months, and other practical uses are bound to emerge.

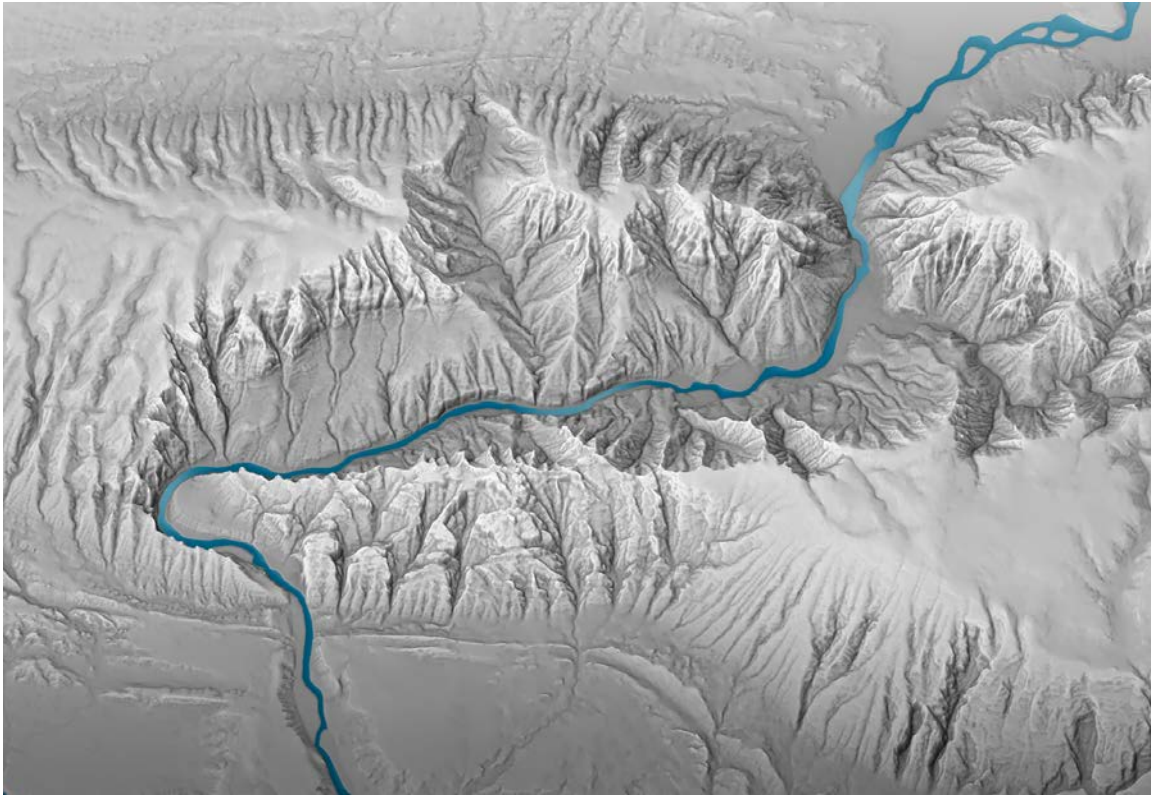


Figure 11. Texture shade applied to a plan oblique map of the Green River and Split Mountain Canyon, Dinosaur National Monument, Utah.

References

Geographx (New Zealand map data)

<http://geographx.co.nz>

Leland Brown's texture shading presentations and command-line application

<https://www.box.net/textureshading>

Natural Scene Designer Pro (software)

<http://www.naturalgfx.com>

Richard Edes Harrison and other manual map samples

<http://www.shadedreliefarchive.com>

Swiss topographic map samples

<http://map.schweizmobil.ch/?lang=en>

Terrain Texture Shader (software)

<http://www.naturalgfx.com/tts.htm>

The Heart of Canyonlands National Park (map)

<http://www.shadedrelief.com/banff/>

The Heart of the Grand Canyon (map)

<http://www.codex99.com/cartography/92.html>

The Going-to-the-Sun Road, Glacier National Park (map)

<http://www.shadedrelief.com/banff/>